a comma to represent the sign of multiplication in almost every equation, invests the expressions with a hopeless obscurity; what for instance would a young student fresh from a little algebra make of the expression (p. 30), cos PC = cos PA, cos CA + sin PA, sin CA, cos PAC whence PC? Mr. Milne's editors and not Mr. Milne are of course to blame for this, though most of the other mistakes alluded to are his own.

In a chapter on the projection of poles by the stereographic method Mr. Milne gives a proposition for finding a pole [he means the projection of a pole] at given angular distances from two poles lying on the circle of projection, which is only a special and simple case of the more general problem. The description of the process is entirely unintelligible. If, however, the meaning be puzzled out from the figure it would seem that Mr. Milne is proposing a construction simple and ingenious, although to obtain it he has to combine the orthographic and stereographic projections. His editors might have saved him from using the expression "two half-hemispheres" on p. 38, if not also from the statement that the monosymmetric or monoclinic system can present eight faces for a single form. The chapter on crystallophysics is very unsatisfactory; after one's expectations of somewhat transcendental physics have been raised by being told that for the correlation of the phenomena produced by crystals with crystal-structure, "the most valuable hypothesis would probably be that of molecular vortices," one is certainly surprised to be told that in the orthorhombic, monoclinic, and triclinic systems "there are two optic axes or directions of double refraction"—or again, that "sections in triclinic crystals cut perpendicularly to the optic axes when viewed in a polariscope show a series of rings round each axis. Between the axes these are drawn together and may meet to form a lemniscate." One is inclined to ask whether Mr. Milne has a distinct idea as to what a lemniscate curve is, and how he cuts the section presenting these phenomena?

In speaking of heat conductivity again, the author places the rhombohedral and orthorhombic systems together in one category, and the tetragonal system in another. The errors, often arising in carelessness but sometimes in ignorance, to which these criticisms apply, have been selected merely at random. It has been necessary, however, to make these criticisms in the interest of the student, who might be repelled from a subject when he finds what should be a simple statement apparently untrue or unintelligible, whether on account of misprints or of obscurity in the language, in the thought, or in the author's method of demonstration. But having performed this duty to the student of a beautiful but much neglected science it would be ungenerous to a teacher in far Japan, not to point out that it is still within his power by recasting his little volume to fill a decided gap in our elementary scientific literature. He has the courage and the ability, he needs only a little more familiarity with the subject, a good deal more caution, and perhaps somewhat more of modesty, to enable him to fulfil the not very ambitious purpose he laid down for himself when he sent his little work to be published in England.

N. S. M.

MATHEMATICAL PROBLEMS

I. *Mathematical Problems on the First and Second Divisions of the Schedule of Subjects for the Cambridge Mathematical Tripos Examination.* Devised and arranged by Joseph Wolstenholme, M.A. Second Edition, greatly enlarged. (London: Macmillan and Co., 1878.)

II. *Solutions of the Cambridge Senate-House Problems and Riders for the Year* 1875. Edited by A. G. Greenhill, M.A. (Same Publishers, 1876.)

III. *The Same for the Year* 1878. Edited by J. W. L. Glaisher, F.R.S. (Same Publishers, 1879.)

IV. *Graduated Exercises in Plane Trigonometry.* Compiled and arranged by J. Wilson, M.A., and J. R. Wilson, B.A. (Same Publishers, 1879.)

V. *Geometrical Deductions, Riders, and Exercises, based upon Euclid, Books I.—IV.* (Stewart's Mathematical Series, 1878.)

A COMMON purpose pervades these five works, viz., that of affording practice and aid in the solution of mathematical problems. Prof. Wolstenholme, with a marvellous versatility which has long placed him in the foremost rank of "ten-minute conundrum" makers, sends forth a volume (I.) which now contains 2,815 problems in place of the 1,628 which he published in 1867. Further, his book has increased in all the directions in which it is possible for a book to grow, and the number of valuable hints scattered throughout the volume has been greatly enlarged. Dipping into the book here and there we are fain to cry out "Prodi-gi-ous!" with worthy Dominie Sampson, and to think this problem-compelling Briareus ever

> "Agitates his anxious breast,
> In solving problems mathematic."

We have long used the earlier work with profit to ourselves, and, we believe, to the advantage of our pupils preparing for Cambridge scholarship examinations; this new edition is an improvement upon the old, and in its line seems now perfect. What we would much like to have is Prof. Wolstenholme's solutions of his questions, but we fear the public, needed for the purchase of such a work, is not yet in existence. Doubtless there are many errors in the text, but these can only be found out by a free and long-extended use; however, we have noted in question 443, for the second $\cos^3\theta$ read $\sin^3\theta$; question 925, for a ? $2a$; p. 192, lines 2, 5, put – before Δ.

In the volumes II., III., we have a welcome revival of a fashion which has of late years died out; it never prevailed to any great extent, but its occurrence was generally traceable to the influence of some one or two enthusiasts, who, for the benefit of junior students, were willing to put upon record neat solutions of elegant problems, not counting the cost of publication. Such collections as these are especially valuable, and the volumes before us seem quite equal to their predecessors in the same field. A novelty in III. is the publication of additional remarks on some of the questions. For instance, a concise general statement of the method of least squares is given on pp. 162-169; on p. 8 is a note on circulating decimals, and similar notes occur elsewhere. In this work (III.) we have detected several small errors, p. 13 line 14 insert – before $\frac{3}{16}a^2$; p. 14

there are three errors; p. 147, line 7, dele "is *r*," there are two other errors on this page; p. 187 we have a vague reference to Boole's Differential Equations, and a misprint lower down; there are other minor errors easily detected, but when correcting pp. 114 to 116, somebody must have had his eyes shut at times or he would not have passed such a number of clerical errors.

In IV. we have a fresh work, well adapted for the higher forms in schools, though the examples are in some cases difficult. There are good notes, and the whole book may be recommended to students reading for scholarship or for college terminal examinations. We could put our finger upon many a mistake easily detected by an advanced student, so that we should advise junior pupils not to spend too long a time upon the questions if they do not succeed in getting the same answer as is given in the text. In making this statement we are bound to say that the number of mistakes seems to be no greater than is almost inevitable in a first edition.

The manual V. contains "more than 160 deductions which have been set at public examinations, worked out in full as examples, together with a collection of specimen examination papers, which have been set at the examinations, Cambridge Mathematical Tripos, London University Matriculation, &c." This fuller title gives a good idea of the scope of the work: it aims at doing for junior students what is done for higher students by McDowell's exercises on Euclid and in Modern Geometry. We have only been able to look into the book casually; we have found the parts so examined correct and put in such a way that a lad acquainted with the text of Euclid ought to have no difficulty in following the proofs here given. The student has to draw his own figures. The printing is good and so done as to assist the reader in his work. From the initials attached to the preface we should infer that the compiler is Mr. A. T. Fisher, whose "Book of Algebra" in the same series we commended, at the time of its publication, in these columns.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Spectrum of Brorsen's Comet

I HAVE to thank Dr. Marshall Watts for having called attention to a point of some interest with regard to the spectra of comets, viz., which of the carbon spectra agrees with the cometary spectrum? In the case of Brorsen's comet the most important question was, whether the spectrum differed *largely* from that of other comets, as found by Dr. Huggins in 1868, and not having much leisure at the time of writing to examine the question of the different spectra of carbon, I overlooked the circumstance that the comparison spectrum used by Prof. Young was the first or flame spectrum of carbon. The difference, however, in the positions of the bands in the two spectra of carbon is a quantity which it is not very easy to answer for in the case of a faint cometary spectrum, and it is but a small fraction (less than one-fourth) of the discordance between Dr. Huggins's measures in 1868 and those made at the present return of the comet.

In the comparisons made at Greenwich the induction-spark (without Leyden jars) was taken in a vacuum-tube containing alcohol vapour at a pressure of 1·2 mm., and the green comet-band was compared with this spectrum exactly in the manner described by Dr. Watts, though practical difficulties of manipulation prevented our making comparisons with the flame spectrum, as I wished. In fact the awkward position of the spectroscope in observing the comet below the pole made the observations extremely difficult, and caused great loss of time, so that the results are not so numerous as they would otherwise have been. On April 17 I used a micrometer eye-piece, with a movable bar, the breadth of which corresponded to 30 tenth-metres, whilst the slit was of such a width that the line with which the band in the alcohol-spectrum commences was 45 tenth-metres broad. The bar was brought up from the blue end so as just not to hide the less refrangible edge of the comet-band; the spectrum from the alcohol vacuum-tube was then flashed in, and the less refrangible edge of the carbon-band was found to be just visible beyond the bar. Several comparisons were made in this way, and I estimated that the uncertainty in the determination of the coincidence between the less refrangible edges of the comet and carbon-bands was but a small fraction of the breadth of the bar (30 tenth-metres). I did not obtain any micrometer readings. On April 19 and 28 Mr. Maunder, from readings with a bright-line micrometer, found for the position of the bright edge of the comet-band in the green, compared with the centre of the line at the edge of the alcohol-band (wave-length, 5198·3):—

	Comet-band. Tenth-metres.	Wave-length inferred.	Width of Slit.
April 19	0·5 to blue	5190	0·009 in. = 16 tenth-metres.
28	4·5 to red	5191	0·013 ,, = 24 ,,

In computing the wave-length of the bright edge of the comet-band, half the breadth of the alcohol-line (= width of slit) has been applied. In a similar manner the wave-length of the bright edge of the comet-band in the yellow was found to be 2·4 tenth-metres to the red of the edge of the alcohol-band at 5610·5, or at 5580, allowing for the width of the slit, which was 0·033 in. or 65 tenth-metres. The position of the blue band was estimated to be *approximately* coincident with the blue band of alcohol at 4834, but this determination is very rough indeed. The dispersion used was that of one "half-prism," viz., 20° from A to H, equivalent to four flint prisms of 60° with a magnifying power of twelve. In my former letter I, by mistake, gave the dispersion as equivalent to two prisms only, instead of four. The high dispersion used is of course an important element in estimating the accuracy of the determination, and on comparing afterwards the flame and vacuum-tube spectra of carbon with the width of slit and other conditions of observation the same as on April 17 and 19, I found the two bands so widely separated that it appeared impossible to mistake one for the other in estimating a coincidence. I may add that the spectrum of Coggia's comet also was found to be identical with the second spectrum of carbon. With regard to Dr. Huggins's observations of Comet II. 1868, and Coggia's comet, Dr. Watts does not give his reasons for the assertion that the comparison spectrum was the first spectrum of carbon. According to the diagram given by Dr. Huggins, the spectrum in olefiant gas is distinctly different from that in olive oil, which I presume is the first spectrum, and the comet-spectrum agrees with the former. As far as I can judge, this is the spectrum which we have obtained in vacuum-tubes, whether they contain alcohol, carbon-oxide, carbon-dioxide, or olefiant gas. I do not wish to enter on the question as to whether the differences in the carbon-spectra result from differences of chemical composition or of molecular condition depending on temperature, though I may remark that the same vacuum-tube gives quite a different spectrum when Leyden jars are introduced into the circuit.

W. H. M. CHRISTIE

Royal Observatory, Greenwich, May 17

End-on Tubes, brought to Bear upon the Carbon and Carbo-Hydrogen Question

IN NATURE, vol. xx. p. 28, there is an important paper by Dr. Marshall Watts, touching certain recent observations of carbon spectra so-called, which seems to offer an excellent opportunity for clearing up certain long-disputed points in spectroscopy, and to the satisfaction, I hope, of every one.

Firstly, the Doctor alludes to the recent happy case of Prof. Young, of Princeton, U.S., having last month compared the green band of Brorsen's comet with the green band of a Bunsen gas burner, and found them identical in spectrum place, thereby